

What is claimed is:

1 1. A halftoning method of converting a
2 multilevel input image into a binary image, comprising
3 the steps of:

4 (a) converting the multilevel value of a given
5 noteworthy pixel of the multilevel input image into
6 a binary value while pixels of the multilevel input
7 image are scanned successively;

8 (b) diffusing a possible error, which has
9 occurred in binary value with respect to the noteworthy
10 pixel, to unscanned pixels adjacent to the noteworthy
11 pixel by one diffusion technique; and

12 (c) changing the technique of said diffusing to
13 another in accordance with a predetermined manner as
14 the scanning of the successive pixels of the multilevel
15 input image progresses.

1 2. A halftoning method according to claim 1,
2 further comprising discriminating whether or not the
3 noteworthy pixel is a pixel constituting part of a
4 profile of the multilevel input image, wherein

5 if the result of said discriminating in step (b)
6 is positive, the error diffusion technique is changed
7 from one to another in step (c).

1 3. A halftoning method according to claim 2,

2 further comprising detecting the direction in which
3 the profile of the multilevel input image extends with
4 respect to the noteworthy pixel, wherein

5 if the result of said discriminating is positive,
6 in step (b),

7 values according to the occurred error are added
8 to the values of the unscanned pixels along the detected
9 direction of the profile as an exceptional process.

1 4. A halftoning method according to claim 1,
2 wherein in step (c) the error diffusion technique is
3 changed for every pixel of the multilevel input image.

1 5. A halftoning method according to claim 4,
2 further comprising discriminating whether or not the
3 noteworthy pixel is a pixel constituting part of a
4 profile of the multilevel input image, and detecting
5 the direction in which the profile of the multilevel
6 input image extends with respect to the noteworthy
7 pixel, wherein

8 if the result of said discriminating is positive,
9 in step (b),

10 values according to the occurred error are added
11 to the values of the unscanned pixels along the detected
12 direction of the profile as an exceptional process.

1 6. A halftoning method according to claim 2,

2 wherein said profile discriminating is carried out
3 by calculating a profile value of the noteworthy pixel
4 based on both the multilevel value of the noteworthy
5 pixel and those of the adjacent pixels, and comparing
6 the calculated profile value with a predetermined
7 value.

1 7. A halftoning method according to claim 3,
2 wherein said profile discriminating is carried out
3 by calculating a profile value of the noteworthy pixel
4 based on both the multilevel value of the noteworthy
5 pixel and those of the adjacent pixels, and comparing
6 the calculated profile value with a predetermined
7 value.

1 8. A halftoning method according to claim 4,
2 wherein said profile discriminating is carried out
3 by calculating a profile value of the noteworthy pixel
4 based on both the multilevel value of the noteworthy
5 pixel and those of the adjacent pixels, and comparing
6 the calculated profile value with a predetermined
7 value.

1 9. A halftoning method according to claim 5,
2 wherein said profile discriminating is carried out
3 by calculating a profile value of the noteworthy pixel
4 based on both the multilevel value of the noteworthy

5 pixel and those of the adjacent pixels, and comparing
6 the calculated profile value with a predetermined
7 value.

1 10. A halftoning method according to claim 6,
2 wherein a two-dimensional digital filter dedicated
3 to enhance the profile is used in said calculating
4 of the profile value.

1 11. A halftoning method according to claim 7,
2 wherein a two-dimensional digital filter dedicated
3 to enhancing the profile is used in said calculating
4 of the profile value.

1 12. A halftoning method according to claim 8,
2 wherein a two-dimensional digital filter dedicated
3 to enhancing the profile is used in said calculating
4 of the profile value.

1 13. A halftoning method according to claim 9,
2 wherein a two-dimensional digital filter dedicated
3 to enhancing the profile is used in said calculating
4 of the profile value.

1 14. A halftoning method according to claim 10,
2 wherein said two-dimensional digital filter dedicated
3 to enhancing the profile is a Laplacian filter.

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1 15. A halftoning method according to claim 11,
2 wherein said two-dimensional digital filter dedicated
3 to enhancing the profile is a Laplacian filter.

1 16. A halftoning method according to claim 12,
2 wherein said two-dimensional digital filter dedicated
3 to enhancing the profile is a Laplacian filter.

1 17. A halftoning method according to claim 13,
2 wherein said two-dimensional digital filter dedicated
3 to enhancing the profile is a Laplacian filter.

1 18. A halftoning method according to claim 10,
2 wherein said two-dimensional digital filter dedicated
3 to enhancing the profile is a Prewitt filter.

1 19. A halftoning method according to claim 11,
2 wherein said two-dimensional digital filter dedicated
3 to enhancing the profile is a Prewitt filter.

1 20. A halftoning method according to claim 12,
2 wherein said two-dimensional digital filter dedicated
3 to enhancing the profile is a Prewitt filter.

1 21. A halftoning method according to claim 13,
2 wherein said two-dimensional digital filter dedicated
3 to enhancing the profile is a Prewitt filter.

1 22. A halftoning method according to claim 6,
2 wherein the profile value is directly calculated by
3 making addition and subtraction individually on the
4 multilevel values of the noteworthy pixel and the
5 adjacent pixels.

1 23. A halftoning method according to claim 7,
2 wherein the profile value is directly calculated by
3 making addition and subtraction individually on the
4 multilevel values of the noteworthy pixel and the
5 adjacent pixels.

1 24. A halftoning method according to claim 8,
2 wherein the profile value is directly calculated by
3 making addition and subtraction individually on the
4 multilevel values of the noteworthy pixel and the
5 adjacent pixels.

1 25. A halftoning method according to claim 9,
2 wherein the profile value is directly calculated by
3 making addition and subtraction individually on the
4 multilevel values of the noteworthy pixel and the
5 adjacent pixels.

1 26. A halftoning method according to claim 1,
2 wherein in said changing step (c), the error diffusion
3 technique is changed to another that is selected in

4 a predetermined order from a plurality of error
5 diffusion techniques.

1 27. A halftoning method according to claim 1,
2 wherein in said changing step (c), the error diffusion
3 technique is changed to another that is selected at
4 random from a plurality of error diffusion techniques.

1 28. A halftoning method according to claim 1,
2 wherein

3 in said error diffusing step (b), the error
4 diffusion technique is a technique of proportionally
5 distributing the occurred error to the plural unscanned
6 pixels adjacent to the noteworthy pixel in accordance
7 with said predetermined weighting pattern, and

8 in said technique changing step (c), the error
9 diffusion technique is changed by changing said
10 predetermined weighting pattern to another.

1 29. A halftoning method according to claim 2,
2 wherein if a plurality of multilevel input images to
3 be halftoned have an approximate profile, said
4 discriminating is carried out for only one of the plural
5 multilevel input images, and the result of said
6 discriminating is used in halftoning the remaining
7 multilevel input images.

1 30. A halftoning method according to claim 3,
2 wherein if a plurality of multilevel input images to
3 be halftoned have an approximate profile, said
4 discriminating is carried out for only one of the plural
5 multilevel input images, and the result of said
6 discriminating is used in halftoning the remaining
7 multilevel input images.

1 31. A halftoning method according to claim 4,
2 wherein if a plurality of multilevel input images to
3 be halftoned have an approximate profile, said
4 discriminating is carried out for only one of the plural
5 multilevel input images, and the result of said
6 discriminating is used in halftoning the remaining
7 multilevel input images.

1 32. A halftoning method according to claim 5,
2 wherein if a plurality of multilevel input images to
3 be halftoned have an approximate profile, said
4 discriminating is carried out for only one of the plural
5 multilevel input images, and the result of said
6 discriminating is used in halftoning the remaining
7 multilevel input images.

1 33. A halftoning apparatus for converting a
2 multilevel input image into a binary image, comprising:
3 a binarizing section for converting the

4 multilevel value of a given noteworthy pixel of the
5 multilevel input image into a binary value while pixels
6 of the multilevel input image are scanned successively;
7 an error diffusing section for diffusing a
8 possible error, which has occurred in binary value
9 with respect to the noteworthy pixel, to unscanned
10 pixels adjacent to the noteworthy pixel by one
11 diffusion technique; and
12 an error diffusion technique changing section
13 for changing said one diffusion technique to another
14 in accordance with a predetermined manner as the
15 scanning of the successive pixels of the multilevel
16 input image progresses.

1 34. A halftoning apparatus according to claim
2 33, further comprising a pixel-on-profile detection
3 section for discriminating whether or not the
4 noteworthy pixel is a pixel constituting part of a
5 profile of the multilevel input image, wherein
6 if the result of the discrimination is positive,
7 said error diffusion technique changing section
8 changes the error diffusion technique from one to
9 another.

1 35. A halftoning apparatus according to claim
2 34, further comprising a direction-of-profile
3 detection section for detecting the direction in which

4 the profile of the multilevel input image extends with
5 respect to the noteworthy pixel, wherein
6 if the result of said discriminating is positive,
7 said error diffusion section performs an exceptional
8 process of adding values according to the occurred
9 error to the values of the unscanned pixels along the
10 detected direction of the profile.

1 36. A halftoning apparatus according to claim
2 33, wherein said error diffusion technique changing
3 section changes the error diffusion technique for every
4 pixel of the multilevel input image.

1 37. A halftoning apparatus according to claim
2 36, further comprising a pixel-on-profile detection
3 section for discriminating whether or not the
4 noteworthy pixel is a pixel constituting part of a
5 profile of the multilevel input image, and a
6 direction-of-profile detection section for detecting
7 the direction in which the profile of the multilevel
8 input image extends, wherein
9 if the result of the discrimination is positive,
10 said error diffusion section performs an exceptional
11 process of adding values according to the occurred
12 error to the values of the unscanned pixels along the
13 detected direction of the profile.

1 38. A computer-readable recording medium in
2 which a halftoning program for instructing a computer
3 to execute a function of converting a multilevel input
4 image into a binary image is recorded, wherein said
5 halftoning program instructs the computer to function
6 as the following:

7 a binarizing section for converting the
8 multilevel value of a given noteworthy pixel of the
9 multilevel input image into a binary value while pixels
10 of the multilevel input image are scanned successively;

11 an error diffusing section for diffusing a
12 possible error, which has occurred in binary value
13 with respect to the noteworthy pixel, to unscanned
14 pixels adjacent to the noteworthy pixel by one
15 diffusion technique; and

16 an error diffusion technique changing section
17 for changing said one diffusion technique of said
18 diffusing to another in accordance with a predetermined
19 manner as the scanning of the successive pixels of
20 the multilevel input image progresses.

1 39. A computer-readable recording medium
2 according to claim 38, wherein said halftoning program
3 instructs the computer to function also as a
4 pixel-on-profile detection section for
5 discriminating whether or not the noteworthy pixel
6 is a pixel constituting part of a profile of the

7 multilevel input image, and if the result of the
8 discrimination is positive, said halftoning program
9 instructs the computer in such a manner that said error
10 diffusion technique changing section changes the error
11 diffusion technique from one to another.

1 40. A computer-readable recording medium
2 according to claim 39, wherein said halftoning program
3 instructs the computer to function also as a
4 direction-of-profile detection section for detecting
5 the direction in which the profile of the multilevel
6 input image extends with respect to the noteworthy
7 pixel, and if the result of said discriminating is
8 positive, said halftoning program instructs the
9 computer in such a manner that said error diffusion
10 section performs an exceptional process of adding
11 values according to the occurred error to the values
12 of the unscanned pixels along the detected direction
13 of the profile.

1 41. A computer-readable recording medium
2 according to claim 38, wherein said halftoning program
3 instructs the computer in such a manner that said error
4 diffusion technique changing section changes the error
5 diffusion technique for every pixel of the multilevel
6 input image.

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1 42. A computer-readable recording medium
2 according to claim 41, wherein said halftoning program
3 instructs the computer to function also as a
4 pixel-on-profile detection section for
5 discriminating whether or not the noteworthy pixel
6 is a pixel constituting part of a profile of the
7 multilevel input image, and a direction-of-profile
8 detection section for detecting the direction in which
9 the profile of the multilevel input image extends,
10 and if the result of the discrimination is positive,
11 said halftoning program instructs the computer in such
12 a manner that said error diffusion section performs
13 an exceptional process of adding values according to
14 the occurred error to the values of the unscanned pixels
15 along the detected direction of the profile.